SUPPLEMENTAL MATERIAL

Table S1. Measurement of Physical Activity by Device Manufacturer*

Manufacturer†	Activity Measurement
Boston Scientific	D-PA is continuously recorded and interpreted by a proprietary algorithm to determine whether a patient is 'active' or 'not active' for a given minute. When patient acceleration exceeds a pre-set threshold of 25 milligravities - equivalent to an approximate walking speed of 2 miles per hour or energy expenditure of 2.8 METS– an "active minute" is recorded. Based on established MET level categories (activity ≤ 2.99 METs = light intensity),[1] D-PA measured by these devices is considered light-intensity activity. A mean value for the amount of time a patient is active each day is calculated and stored in device memory for up to 1 year.[2-10]
Medtronic	D-PA is continuously recorded and interpreted with a proprietary algorithm that calculates the total number of active minutes per day based on a pre-set threshold. Patient acceleration that is equivalent to a walking rate of approximately 70 steps per minute is considered an active minute. Since a stepping rate equal to 100 steps/minute is considered moderate-intensity physical activity,[1] D-PA measured by Medtronic CIEDs falls between light and moderate-intensity activity (e.g., walking at a slow pace). A summary score for total activity in minutes per day is automatically calculated and stored in device memory for up to 14 months.[11-28]
Biotronik and St. Jude	Less information is readily available concerning Biotronik and St.Jude devices, however, both describe time for which sensor input exceeds resting heart rate. In prior studies, Biotronik D-PA data are reported as the percentage of time a patient is active each day[29, 30] whereas St. Jude devices report daily activity in units of hours/day.[27]

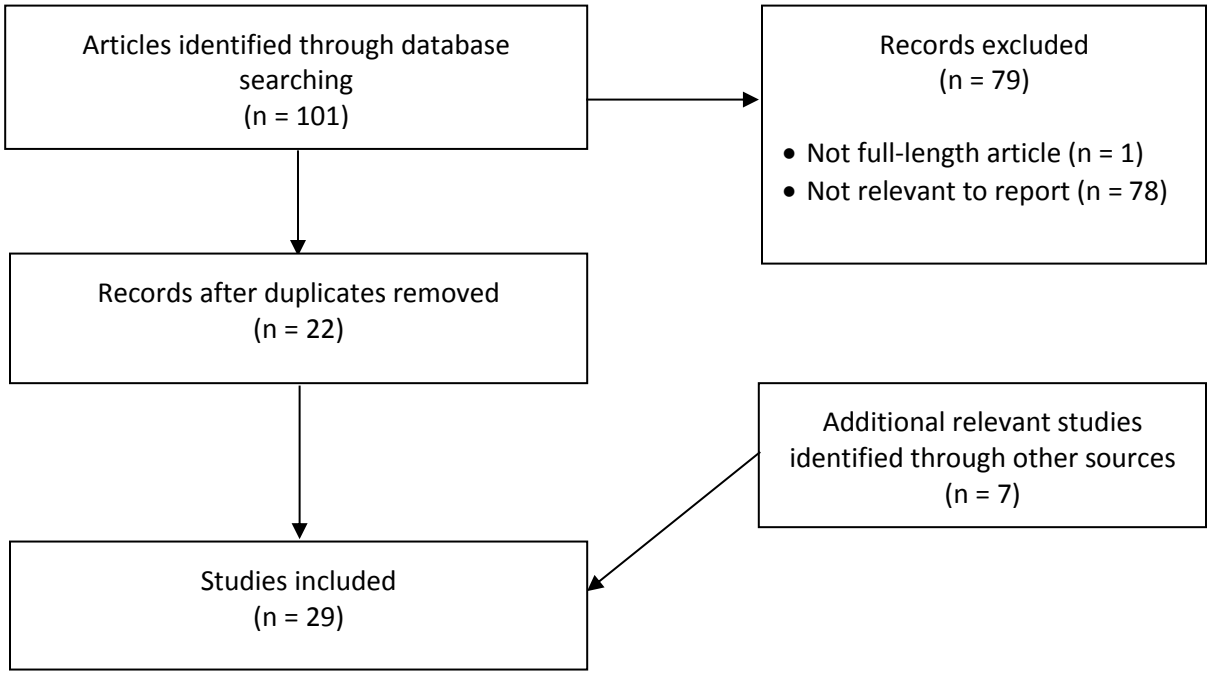
*Information was obtained from publications in peer-reviewed journals and data publicly available on manufacturers websites.

†Device manufacturers: Boston Scientific (formally Guidant Corporation; Boston Scientific Corp, Natick, MA); Medtronic (Medtronic Inc., Minneapolis, Minnesota); Biotronik (Biotronik, Berlin, Germany; and St. Jude Medical device (St Jude Medical Inc., Sylmar, California).

Table S2. Summary of the Strengths and Limitations of D-PA Technology and Extant Research.

Strengths
• CIED accelerometers are built directly into the device and do not require patient participation or additional costs to obtain long-term activity measurements. In contrast, only 12.5% of adults in the US own a wearable fitness tracker (e.g., Fitbit or Actigraph watches, or cellphone app-based tracker)[31] and data from wearable activity trackers are rarely included in medical records. • Device diagnostic information and activity data are collected concurrently and stored for extended periods, making this information uniquely well-suited for examining clinical trends over time, and for longitudinal research. • CIED accelerometers provide continuous objective activity measurement compared to patient-reported activity, which is subjective and less accurate, and traditional activity questionnaires may increase provider and patient burden.[32, 33] • D-PA data are readily available (via device manufacturers) and routinely uploaded into patient electronic-medical records (via device interrogation reports), creating immediate opportunities for use in both research and clinical settings.
Limitations
• CIED accelerometers were developed for the primary purpose of rate-responsive pacing and were not designed to capture data concerning activity type or intensity. • Whether CIED accelerometers are sensitive to detecting D-PA from a broad range of activities (e.g., bicycling, swimming, household chores) is unknown.[8, 17] • Thresholds used to infer meaningful activity from CIED accelerometers differ across manufacturers. • Underrepresentation of women and racial and ethnic minorities limits the generalizability of D-PA findings. Only one published study has examined D-PA in pediatric device patients and activity data in patients with pacemakers is limited. • Heterogeneity in the measurement of D-PA (3 published studies[22-24] used a 'visual estimate' based on activity graphs obtained from clinical reports to measure patient activity) and mortality (deaths reported in clinical trials vs. data obtained from the Social Security Death Index)[8] contribute to inconsistent findings across studies. • Few studies adequately controlled for clinical factors that can influence daily activity in device patients (e.g., episodes of ICD shock and time spent in hospital), or for medical conditions, injuries or symptoms that interfere with ambulatory movement measured by CIED accelerometer (amputation, chronic pain, pulmonary disease, peripheral artery disease, diabetic neuropathy, and osteoporosis).

Figure S1. PRISMA Diagram.



Supplemental References:

1. Tudor-Locke C, Sisson SB, Collova T, Lee SM, Swan PD. Pedometer-determined step count guidelines for classifying walking intensity in a young ostensibly healthy population. *Can J Appl Physiol*. 2005;30:666-676.
2. Boehmer JP, Hariharan R, Devecchi FG, Smith AL, Molon G, Capucci A, An Q, Averina V, Stolen CM, Thakur PH, Thompson JA, Wariar R, Zhang Y, Singh JP. A multisensor algorithm predicts heart failure events in patients with implanted devices: Results from the multisense study. *JACC Heart Fail*. 2017;5:216-225.
3. Gilliam FR, Kaplan AJ, Black J, Chase KJ, Mullin CM. Changes in heart rate variability, quality of life, and activity in cardiac resynchronization therapy patients: Results of the hf-hrv registry. *Pacing and Clinical Electrophysiology*. 2007;30:56-64.
4. Jamé S, Kutyifa V, Polonsky B, McNitt S, Al-Ahmad A, Moss AJ, Zareba W, Wang PJ. Predictive value of device-derived activity level for short-term outcomes in madit-crt. *Heart Rhythm*. 2017;14:1081-1086.
5. Kadhiresan VA, Pastore J, Auricchio A, Sack S, Doelger A, Girouard S, Spinelli JC. A novel method--the activity log index--for monitoring physical activity of patients with heart failure. *Am J Cardiol*. 2002;89:1435-1437.
6. Kawabata M, Fantoni C, Regoli F, Raffa S, Pastori F, Fratini S, Prentice J, Klein HU, Auricchio A. Activity monitoring in heart failure patients with cardiac resynchronization therapy. *Circulation Journal*. 2007;71:1885-1892.
7. Kramer DB, Jones PW, Rogers T, Mitchell SL, Reynolds MR. Patterns of physical activity and survival following cardiac resynchronization therapy implantation: The altitude activity study. *Europace*. 2017;19:1841-1847.
8. Kramer DB, Mitchell SL, Monteiro J, Jones PW, Normand SL, Hayes DL, Reynolds MR. Patient activity and survival following implantable cardioverter-defibrillator implantation: The altitude activity study. *J Am Heart Assoc*. 2015;4:e001775 doi: 001710.001161/JAHA.001115.001775.
9. Kramer DB, Tsai T, Natarajan P, Tewksbury E, Mitchell SL, Travison TG. Frailty, physical activity, and mobility in patients with cardiac implantable electrical devices. *J Am Heart Assoc*. 2017;6:e004659. doi: 004610.001161/JAHA.004116.004659.
10. Singh JP, Rosenthal LS, Hranitzky PM, Berg KC, Mullin CM, Thackeray L, Kaplan A. Device diagnostics and long-term clinical outcome in patients receiving cardiac resynchronization therapy. *EP Europace*. 2009;11:1647-1653.
11. Adamson PB, Smith AL, Abraham WT, Kleckner KJ, Stadler RW, Shih A, Rhodes MM. Continuous autonomic assessment in patients with symptomatic heart failure: Prognostic value of heart rate variability measured by an implanted cardiac resynchronization device. *Circulation*. 2004;110:2389-2394.
12. Braunschweig F, Mortensen PT, Gras D, Reiser W, Lawo T, Mansour H, Sogaard P, Stegemann B, Bruns HJ, Linde C. Monitoring of physical activity and heart rate variability in patients with chronic heart failure using cardiac resynchronization devices. *Am J Cardiol*. 2005;95:1104-1107.
13. Chelu MG, Gunderson BD, Koehler J, Ziegler PD, Sears SF. Patient activity decreases and mortality increases after the onset of persistent atrial fibrillation in patients with implantable cardioverter-defibrillators. *JACC: Clinical Electrophysiology*. 2016;2:518-523.

14. Conraads VM, Spruit MA, Braunschweig F, Cowie MR, Tavazzi L, Borggrefe M, Hill MR, Jacobs S, Gerritse B, van Veldhuisen DJ. Physical activity measured with implanted devices predicts patient outcome in chronic heart failure. *Circ Heart Fail*. 2014;7:279-287.
15. Cowie MR, Sarkar S, Koehler J, Whellan DJ, Crossley GH, Tang WH, Abraham WT, Sharma V, Santini M. Development and validation of an integrated diagnostic algorithm derived from parameters monitored in implantable devices for identifying patients at risk for heart failure hospitalization in an ambulatory setting. *Eur Heart J*. 2013;34:2472-2480.
16. de la Uz CM, Burch AE, Gunderson B, Koehler J, Sears SF. How active are young cardiac device patients? Objective assessment of activity in children with cardiac devices. *Pacing and Clinical Electrophysiology*. 2017;40:1286-1290.
17. Pressler A, Danner M, Esefeld K, Haller B, Scherr J, Schömig A, Halle M, Kolb C. Validity of cardiac implantable electronic devices in assessing daily physical activity. *International Journal of Cardiology*. 2013;168:1127-1130.
18. Sears SF, Rosman L, Sasaki S, Kondo Y, Sterns LD, Schloss EJ, Kurita T, Meijer A, Raijmakers J, Gerritse B, Auricchio A. Defibrillator shocks and their impact on objective and subjective patient outcomes: Results from the painfree sst clinical trial. *Heart Rhythm*. 2017 doi: 10.1016/j.hrthm.2017.12.026. [Epub ahead of print].
19. Sears SF, Whited A, Koehler J, Gunderson B. Examination of the differential impacts of antitachycardia pacing vs. Shock on patient activity in the empiric study. *EP Europace*. 2015;17:417-423.
20. Sharma V, Rathman LD, Small RS, Whellan DJ, Koehler J, Warman E, Abraham WT. Stratifying patients at the risk of heart failure hospitalization using existing device diagnostic thresholds. *Heart & Lung: The Journal of Acute and Critical Care*. 2015;44:129-136.
21. Shoemaker MJ, Cartwright, K., Hanson, K., Serba, D., Dickinson, M. G., & Kowalk, A. . Concurrent validity of daily activity data from medtronic icd/crt devices and the actigraph gt3x triaxial accelerometer: A pilot study. *Cardiopulmonary Physical Therapy Journal*. 2017;28:3-11.
22. Shoemaker MJ, Curtis AB, Paul R, Dickinson MG, Polso A, Sinha K. Longitudinal daily activity patterns in individuals with heart failure: Derivation and association with prognosis and clinical characteristics. *Cardiopulmonary Physical Therapy Journal*. 2013;24:25-33.
23. Shoemaker MJ, Roper SE, Calkins TN. Seasonal variation of daily physical activity in individuals with heart failure. *Heart International*. 2016;11:e25-e31.
24. Shoemaker MJ CA, Vangsnes E, Dickinson MG, Paul R. Analysis of daily activity from implanted cardiac defibrillators: The minimum clinically important difference and relationship to mortality/life expectancy. *World J Cardiovasc Dis*. 2012;2:129-135.
25. Small RS, Wickemeyer W, Germany R, Hoppe B, Andrulli J, Brady PA, Labeau M, Koehler J, Sarkar S, Hettrick DA, Tang WH. Changes in intrathoracic impedance are associated with subsequent risk of hospitalizations for acute decompensated heart failure: Clinical utility of implanted device monitoring without a patient alert. *J Card Fail*. 2009;15:475-481.

26. Tyagi S, Curley M, Berger M, Fox J, Strath SJ, Rubenstein J, Roth J, Widlansky ME. Pacemaker quantified physical activity predicts all-cause mortality. *Journal of the American College of Cardiology*. 2015;66:754-755.
27. Vegh EM, Kandala J, Orencole M, Upadhyay GA, Sharma A, Miller A, Merkely B, Parks KA, Singh JP. Device-measured physical activity versus six-minute walk test as a predictor of reverse remodeling and outcome after cardiac resynchronization therapy for heart failure. *Am J Cardiol*. 2014;113:1523-1528.
28. Whellan DJ, Ousdigian KT, Al-Khatib SM, Pu W, Sarkar S, Porter CB, Pavri BB, O'Connor CM. Combined heart failure device diagnostics identify patients at higher risk of subsequent heart failure hospitalizations: Results from partners hf (program to access and review trending information and evaluate correlation to symptoms in patients with heart failure) study. *J Am Coll Cardiol*. 2010;55:1803-1810.
29. Melczer C, Melczer L, Goják I, Oláh A, Ács P. A comparative analysis between external accelerometer and internal accelerometer's physical activity data from implanted resynchronization devices in patients with heart failure. *European Journal of Integrative Medicine*. 2016;8, Supplement 2:18-22.
30. Zhao S, Chen K, Su Y, Hua W, Chen S, Liang Z, Xu W, Dai Y, Liu Z, Fan X, Hou C, Zhang S. Association between patient activity and long-term cardiac death in patients with implantable cardioverter-defibrillators and cardiac resynchronization therapy defibrillators. *Eur J Prev Cardiol*. 2017;24:760-767.
31. Omura JD, Carlson SA, Paul P, Watson KB, Fulton JE. National physical activity surveillance: Users of wearable activity monitors as a potential data source. *Preventive Medicine Reports*. 2017;5:124-126.
32. Schuna JM, Johnson WD, Tudor-Locke C. Adult self-reported and objectively monitored physical activity and sedentary behavior: Nhanes 2005–2006. *International Journal of Behavioral Nutrition and Physical Activity*. 2013;10:126.
33. Dyrstad SM, Hansen BH, Holme IM, Anderssen SA. Comparison of self-reported versus accelerometer-measured physical activity. *Med Sci Sports Exerc*. 2014;46:99-106.